IS 11880 (1986): Piezoelectric Ceramic Trilaminate Elements Used in Phonograph Pick-ups, Ultrasonic Transducers and Similar Devices [LITD 5: Semiconductor and Other Electronic Components and Devices]

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Indian Standard

SPECIFICATION FOR PIEZOELECTRIC CERAMIC TRILAMINATE ELEMENTS USED IN PHONOGRAPH PICK-UPS, ULTRASONIC TRANSDUCERS AND SIMILAR DEVICES

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BUREAU OF INDIAN STANDARDS
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SPECIFICATION FOR PIEZOELECTRIC CERAMIC TRILAMINATE ELEMENTS USED IN PHONOGRAPH PICK-UPS, ULTRASONIC TRANSDUCERS AND SIMILAR DEVICES

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Indian Standard

SPECIFICATION FOR PIEZOELECTRIC CERAMIC TRILAMINATE ELEMENTS USED IN PHONOGRAPH PICK-UPS, ULTRASONIC TRANSDUCERS AND SIMILAR DEVICES

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 26 November 1986, after the draft finalized by the Piezoelectric Devices for Frequency Control and Selection Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The object of this standard is to cover the requirements and methods of tests of the piezoelectric ceramic trilaminate elements used in phonograph pick-ups, ultrasonic transducers and similar devices.

0.3 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies the requirements and the methods oftests for piezoelectric ceramic trilaminate elments used in phonograph pick-ups, ultrasonic transducers and similar devices.

NOTE — This standard applies only to piezoelectric ceramic trilaminate elements having construction as shown in Fig. 1.

*Rules for rounding off numerical values (*revised*).

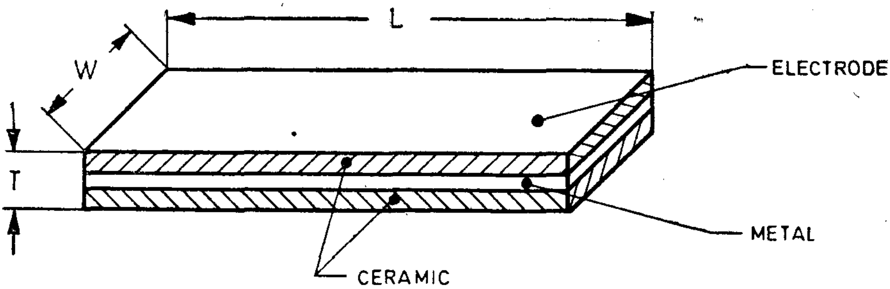


FIG. 1 PIEZOELECTRIC CERAMIC TRILAMINATE ELEMENT

2. TERMINOLOGY

2.1 For the purpose of this standard the terms and definitions covered by IS : 1885 (Part 44)-1978* and IS : 11014 (Part 1)-1984† shall apply.

3. PIEZOELECTRIC CERAMIC MATERIAL

3.1 The material of piezoelectric ceramic trilaminate elements shall be in accordance with Type 5 of IS : 11014 (Part 2)-1984‡.

4. PIEZOELECTRIC CERAMIC TRILAMINATE ELEMENTS

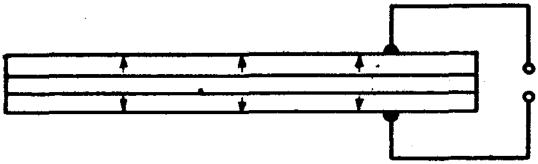
4.1 General — Piezoelectric ceramic trilaminate element is capable of oscillating in flexural mode. A voltage applied to the electrodes comprising the outside face results in a bending action. Conversely mechanical bending of the element causes it to develop a corresponding voltage between the electrodes.

4.2 Construction — These elements are fabricated using thin plates of thickness-wise poled piezoelectric ceramic material with a metallic reed sandwiched between them thus forming trilaminate construction. Then two plates are joined such that their direction of polarity is opposite to each other for series connection [*see* Fig. 2(a)] and is in the same direction for parallel connection [*see* Fig. 2(b)]. These elements shall be electroded on both sides.

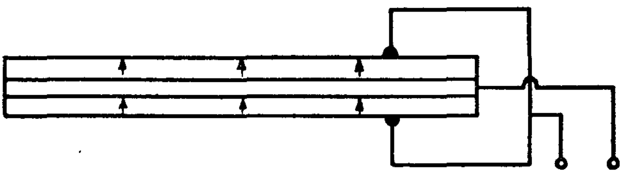
*Electrotechnical vocabulary: Part 44 Piezoelectric devices.

†Specification for piezoelectric ceramic material: Part 1 General aspects and methods of measurements.

‡Specification for piezoelectric ceramic materials: Part 2 Types 1 and 5.



2A OPPOSITE POLARITY FOR SERIES CONNECTION



2B SAME POLARITY FOR PARALLEL CONNECTION

FIG. 2 DIRECTION FOR POLARITY IN PIEZOELECTRIC CERAMIC TRILAMINATE ELEMENTS

4.3 Dimensions — These elements are fabricated in various sizes to suit a wide range of applications. Usually, these elements are made having same thickness but different length and width.

4.3.1 The typical sizes of these elements are given in Table 1.

TABLE 1 DIMENSIONS OF RECTANGULAR PIEZOELECTRIC CERAMIC TRILAMINATE ELEMENTS (FIG. 1)

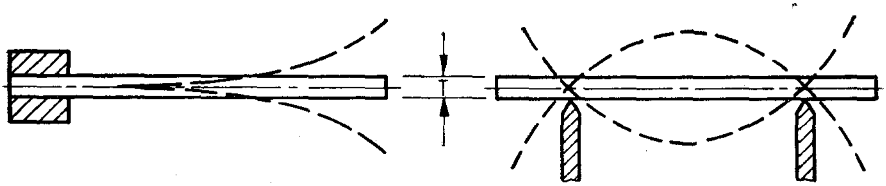
DIMENSIONS	PHONOGRAPH, PICKUP ELEMENTS		ULTRASONIC TRANSDUCERS AND SIMILAR DEVICES	
	Size (mm)	Tolerance (mm)	Size (mm)	Tolerance (mm)
(1)	(2)	(3)	(4)	(5)
Length (L)	13·6	± 0·20	6 to 45	± 0·20
Width (W)	1·6	± 0·10	1·5 to 6·5	± 0·10
Thickness (T)	0·6	± 0·05	0·6	± 0·05

5. MOUNTING

5.1 The performance of these elements depends upon the mounting as it constrains the elements. The most common means of mounting these elements as shown in Fig. 3 are:

a) cantilever beam mounting; and

b) simple beam mounting.



3A CANTILEVER

3B SIMPLE BEAM

FIG. 3 CANTILEVER AND SIMPLE BEAM MOUNTING OF ELEMENT

6. PARAMETERS AND CHARACTERISTICS

6.1 The parameters of the piezoelectric ceramic trilaminate element may be represented by means of an electromechanical equivalent circuit shown in Fig. 4.

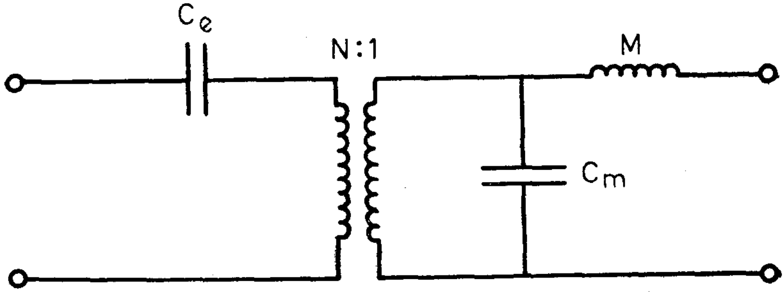


FIG. 4 ELECTROMECHANICAL EQUIVALENT CIRCUIT

where

Ce = equivalent electrical capacitance in pF,

N = equivalent electromechanical linear transducer ratio in Volts/Newton or metres/Coulomb,

Cm = equivalent mechanical compliance in metres/Newton, and

M = equivalent effective mass in kg.

6.1.1 The value of the parameters of equivalent circuit, except *Ce* will depend upon the method of mounting. These parameters shall have the minimum value as given in Table 2.

TABLE 2 ELECTROMECHANICAL EQUIVALENT CIRCUIT PARAMETERS

Mounting	$\frac{Cm}{(m/N)}$	$\frac{M}{(kg)}$	$\frac{Ce}{(pF)}$	$\frac{N}{(V/N)}$
Cantilever	$7\times10^{-8}\frac{L^3}{WT^3}$	$2{\cdot}0\times10^{-6}LWT$	$17{\cdot}5\,\frac{LW}{T}$	$2{\cdot}3\times10^{-2}\frac{L}{WT}$
Simple beam (Nodal Support)	$4\times10^{-9}\frac{L^3}{WT^3}$	$4{\cdot}0\times10^{-6}LWT$	$17{\cdot}5\,\frac{LW}{T}$	$5{\cdot}9\times10^{-3}\frac{L}{WT}$

NOTE — L, W & T are in metres.

6.2 The characteristics of the element shall be specified in terms of its equivalent circuit parameters (*see* **6.1.1**) in the following manner:

Resonant frequency $\qquad fr = \frac{1}{2\pi\sqrt{M\,Cm}}$

Voltage developed $\qquad V = N \times F$
where F is the applied force

Displacement $\qquad D = N \times Ce \times V$
where V is the applied voltage

Displacement (D) $\qquad D = Cm \times F$
where F is the applied force

7. METHODS OF TESTS

7.1 Capacitance — The capacitance of the element shall be measured at 1 KHz. It shall be a minimum of 16·5 LW/T pF.

7.2 Breaking Strength — The breaking strength of the element shall be tested in the set-up shown in Fig. 5. The element shall not break a force test 900 g in case of phonograph pickup element. For element of other applications the value of force, if required, will be as agreed between the manufacturers and users.

7.3 Output Voltage

7.3.1 The element shall be supported on two knife edges at a distance of 10 mm apart (*see* Fig. 6). Another clamping knife edge is placed above the element at the centre of two supporting knife edges. The clamping force on the element by the clamping knife edge shall be 200 mN. A sinusoidal force of 100 mN is applied at 1 KHz frequency over the clamping knife edge such that the force vs time graph is as shown in Fig. 7.

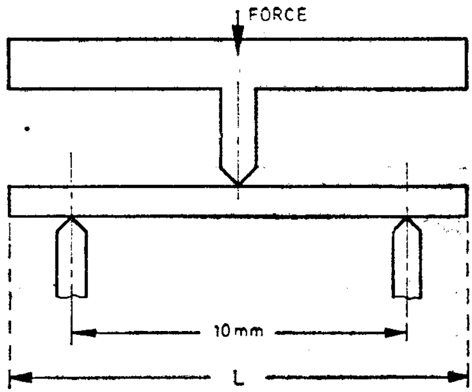


FIG. 5 SET-UP FOR BREAKING STRENGTH

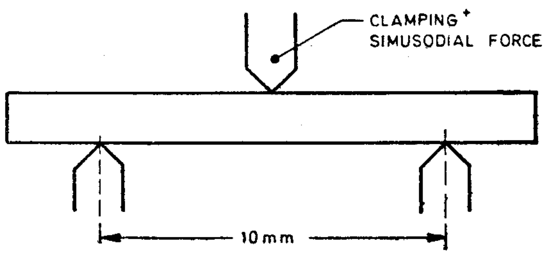


FIG. 6 ARRANGEMENT FOR CLAMPING

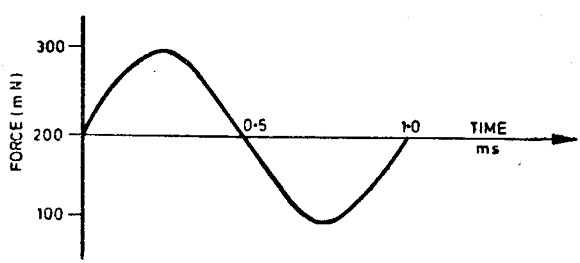


FIG. 7 FORCE *vs* TIME GRAPH

7.3.2 All the three knife edges shall have built-in electrical points so as to have contacts with silver electrodes on the element. The output voltage shall be measured by an ac voltmeter.

7.3.3 The output voltage as measured shall be a minimum of 110 mV in case of phonograph pickup element. For elements of other applications, the value shall be as agreed between the manufacturers and the users.

7.4 Linearity — The linearity of the elements shall be better than 5 percent in the frequency range 20 Hz to 16 KHz when measured in the set up described in **7.3** with frequency of sinusoidal force varying between 20 Hz and 16 KHz.

7.5 Resistonce — The resistance of the elements shall be more than 10^{12} ohms.

8. CONNECTIONS

8.1 The electrical connections from the element shall be made as specified by the manufacturer, which shall be either by soldering leads or by pressure contacts.

9. MARKING

9.1 Each carton containing the elements shall have the following information clearly and indelibly marked on it:

a) Manufacturer's name or trade mark,

b) Polarity of the element,

c) Size of the element, and

d) Country of manufacture.

9.2 The carton may also be marked with the Standard Mark.

NOTE — The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act 1986 and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers, may be obtained from the Bureau of Indian Standards.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Uuits

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N $=$ 1 kg,m/s^2
Energy	joule	J	1 J $=$ 1 N.m
Power	watt	W	1 W $=$ 1 J/s
Flux	weber	Wb	1 Wb $=$ 1 V.s
Flux density	tesla	T	1 T $=$ 1 Wb/m^2
Frequency	hertz	Hz	1 Hz $=$ 1 c/s(s^{-1})
Electric conductance	siemens	S	1 S $=$ 1 A/V
Electromotive force	volt	V	1 V $=$ 1 W/A
Pressure, stress	pascal	Pa	1 Pa $=$ 1 N/m^2